Emission Reduction Calculation Roadmap

"MEASURES" SOPO Task 1.3

The "MEASURES" project seeks to develop Evaluation, Measurement, and Verification protocols and an energy efficiency/carbon emissions tracking approach that integrate non-ratepayer funded energy savings performance contracting programs into compliance plans for the U.S. EPA's Clean Power Plan. Task 1.3 is to determine an emissions reduction calculation process for ESPC projects to be shared with states and other project advisors.

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Executive Summary

Energy-saving performance contracts (ESPCs) are widely used to engage private capital in making facility improvements that "pay for themselves" through avoided costs of energy (and other commodities such as water). Generally the savings are sufficiently large relative to financing the project that property owners immediately achieve positive cash flow. The benefits of ESPCs include capital improvements (without the owner needing to invest capital), enhanced facility value, greater reliability of energy- and water-using systems, reduction in energy, water, and maintenance costs[1], a number of qualitative benefits like greater comfort, resilience, safety, and health, and reductions in greenhouse gas (GHG) and other emissions. A portion of this last benefit, computing avoided carbon dioxide (CO_2) emissions, is the subject of this paper.

ESPCs lower energy demand, thereby reducing CO_2 and other emissions from both onsite fuel combustion (e.g., in boilers and furnaces) and indirectly from fossil-fueled electrical generation units (EGUs) supplying electricity to the facility.[2] This indirect result is complicated to demonstrate and quantify.

The Energy Offices of the States of Georgia, Kentucky, and Virginia have joined to seek a regional consensus on how to evaluate, measure, and verify the avoided consumption of electrical energy, and the resulting avoided emissions from EGUs. Their effort is supported in part by a cooperative agreement with the U.S. Department of Energy (DOE),[3] whose statement of project objectives (SOPO) includes a Deliverable 1.3 "Draft emissions reduction calculation roadmap shared with states and other project advisors." The following pages provide such a "roadmap."

States can meet several objectives by following the roadmap:

- To meet and document state and regional clean air goals or standards,
- To track ESPC investment and savings data, and benchmark performance against a national database,
- To understand when and where EGUs' generation may be displaced by ESPC impacts, which may be important to EE impact evaluations, utility and regulatory planning, and grid congestion analysis,
- To establish a basis for future trading of avoided-emission units in voluntary or potential compliance markets,
- To share with other states and DOE a consensus methodology and experience, as proposed in the SOPO, and
- To support each state's response to the Clean Power Plan (CPP) rule promulgated by the U.S. Environmental Protection Agency (EPA), particularly to integrate ESPC savings into CPP state compliance plans.

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1 The reduced costs are partially or wholly offset by debt service expense until the ESPC investment is repaid.

2 In principle ESPC-derived energy savings can reduce emissions in other ways too, such as from onsite power generation and purchases of offsite generated steam or chilled water as well as reducing various emissions via energy recovery from waste and byproduct gases from various industrial and waste treatment processes.

3 Insert Cooperative agreement citation

This last objective, integrating measured and verified ESPC savings into CPP compliance plans, is a significant part of the SOPO and treated at length in this paper. The SOPO was drafted,however, before EPA revised the 2014 CPP proposal into the final rule issued in August 2015.[4] The final rule removes the necessity of translating ESPC electricity savings (in MWh) into CO_2 emission reductions (in tons) *for purposes of compliance*. EPA will now accept each measured and verified MWh (of avoided electric energy consumption) for full credit, irrespective of when and where on the electric grid that occurs and what marginal emission impacts result.

The emission-conversion pathways described in this paper are therefore relevant to the first five objectives listed above, but not to CPP *compliance*. This does not mean that ESPC savings are not important to state CPP strategies, only that the translation of such savings into tons of CO_2 emission reductions is unnecessary to satisfy EPA. Although the simplified CPP no longer *requires* the conversion, states may want to *compute* the conversion so they can forecast the emission-reduction impact of ESPC savings (as well as of savings from other policies, programs, and measures).

Even with this simplification, the CPP and its options for compliance remain a complex subject. This report is not a roadmap for CPP compliance, which requires a number of decisions on the part of state air-quality offices and others beyond the scope of this cooperative agreement. This Emission Reduction Calculation Roadmap describes means of translating or converting measured electrical energy consumption reductions into CO_2 emission reductions, which should be helpful to those considering such decisions even though not required specifically for CPP compliance.

The Roadmap (depicted on page 11) places the MWh-to- CO_2 translation in the context of an over-all plan to track and extract value from ESPC savings. It begins with collaboration and moves through EM&V (the subject of the Task 1.2 report), use of the "eProjectBuilder" national database developed by LBNL with DOE support (Task 2.1 report), emission conversion options, and a registry to establish trading values and credits. This provides opportunity for both unambiguous tracking of ESPC results and maximization of their potential values in trading or as CPP credits.

[4] Officially published in the *Federal Register* on October 23, 2015 (80 FR 64662-65120). The rule is 40 CFR Part 60 Subpart UUUU Emission Guidelines for Greenhouse Gas Emissions and Compliance Times for Electric Generating Units. EPA simultaneously issued proposed Federal Plan Requirements and Model Trading Rules that are open for comment until January 21, 2016 as well as in a non-regulatory action issuing proposed draft evaluation, measurement, and verification (EM&V) guidance.

List of Acronyms

AVERT: Avoided Emissions and Generation Tool

CO2: Carbon Dioxide

CPB: Common Practice Baseline

CPP: Clean Power Plan

CSAPR: Cross-State Air Pollution Rule

DEQ: (Virginia) Department of Environmental Quality

DMME: (Virginia) Department of Mines, Minerals, and Energy

DOE: (U.S.) Department of Energy

DSM: Demand-Side Management

ECM: Energy Conservation Measure

EE: Energy Efficiency

EEPS: Energy Efficiency Portfolio Standards

EERS: Energy Efficiency Resource Standards

EGU: Electric Generating Unit(s)

EM&V: Evaluation, Measurement, and Verification

EPA: (U.S.) Environmental Protection Agency

ePB: eProject Builder

ESCO: Energy Services Company

ESPC: Energy-Savings Performance Contract

ERC: Emission Rate Credit

FEMP: Federal Energy Management Program

GHG: Greenhouse Gas

GWh: Gigawatt Hour

HVAC: Heating, Ventilation, and Air Conditioning

IGA: Investment Grade Audit

IPMVP: International Performance Measurement and Verification Protocol

kWh: Kilowatt Hour

LBNL: Lawrence Berkeley National Laboratory

MATS: Mercury and Air Toxics Standards

MEASURES: Developing Consistency in EM&V Approaches and Emissions Reduction Calculations for Energy Performance Contracting Programs

MMBtu: one million British Thermal Units

M&V: Measurement and Verification

MWh: Megawatt Hour

NACAA: National Association of Clean Air Agencies

NAESCO: National Association of Energy Services Company

NARUC: National Association of Regulatory Utility Commissioners

NASUCA: National Association of State Utility Consumer Advocates

NOx: Nitrous Oxide

O&M: Operations & Maintenance

PUC: Public Utilities Commission

PV: Photovoltaic

RAP: Regulatory Assistance Project

RE: Renewable Energy

RTO: Regional Transmission Operator

SEEA: Southeast Energy Efficiency Alliance

SO_2: Sulfur Dioxide

SOPO: Statement of Project Objectives

TRM: Technical Reference Manual

TVA: Tennessee Valley Authority

UMP: Uniform Methods Project

VEIC: Vermont Energy Investment Corporation

VEMP: Virginia Energy Management Program

Introduction

In January 2015, the Virginia Department of Mines, Minerals, and Energy (DMME) began work under a Department of Energy (DOE) Competitive Grant that seeks to develop evaluation, measurement, and verification (EM&V) protocols and an energy efficiency/carbon emission reductions tracking approach that integrate non-ratepayer-funded energy savings performance contracting (ESPC) programs into compliance plans for the U.S. Environmental Protection Agency's Clean Power Plan (CPP). Task 1.3 of the "Developing Consistency in EM&V Approaches and Emissions Reduction Calculations for Energy Savings Performance Contracting Programs," or "MEASURES" grant is to determine an emissions reduction calculation process for ESPC projects, with a Q3 Milestone and Deliverable of a "Roadmap Report," shared with the states and other project advisors.

Tasks 1.1-1.2 have dealt with consistent EM&V practices and filling gaps in their application. Task 2 will deal with tracking, recording, and trading considerations. The immediate purpose of this Task 1.3 is to lay out an actionable emission-reduction calculation process that the states can put into practice, using the most consistent and best available EM&V practices and data.

Objective and Scope

The destination of this Roadmap is the quantification, attribution, registration, and valuation (via a market) of carbon dioxide (CO2) emission reductions resulting from energy-saving performance contracts (ESPCs).[5] The roadmap begins with measuring and verifying ESPC savings reported by the ESCOs, and ends with trading and "surrender" of emission rate credits (ERCs) and their associated CO2 emitted-mass reductions.

"Quantification" means the unambiguous counting of defined units of reductions (ERCs in MWh, CO2 mass in short tons), proven to the satisfaction of relevant state, federal, and industry standards.

"Attribution" means the assignment of source and ownership to the parties responsible for creating this value.

"Registration" means the attachment of unique identifiers to each unit, maintaining an inventory of all such units and their ownership, and recording the retirement or surrender each unit once (and if) monetized, so it cannot be double-counted.

"Valuation" means establishing a basis for monetizing these units into present or future cash or other forms of credit or exchange.

It should be noted that the final Clean Power Plan, published in the Federal Register in October 2015,[6] does not require an energy savings-to-CO2 conversion of electricity savings into avoided

[5] The processes described herein will be useful in converting sources other than ESPC savings into emission reductions, whether CO_2 or other emissions.
[6] EPA Clean Power Plan Final Rule, 80 F.R. 64662. (Oct. 23, 2015) (to be codified at 40 C.F.R. Part 60) .

emissions for the narrow purpose of compliance with the rule.[7] To simplify compliance, the Final Rule dropped its distinctions of both time and place of emission reductions.[8] A MWh of avoided consumption is now 100% convertible into an ERC (subject to meeting EPA eligibility and EM&V requirements) in states opting for rate-based targets, whether the consumption was avoided during peak or other hours and irrespective of the location of the electric generating units (EGUs) whose generation was curtailed; i.e., the marginal emissions rate for a given MWh saved is no longer relevant to Clean Power Plan compliance. Besides meeting the requirements for this SOPO Deliverable, translating electricity savings into avoided emissions remains important to the States, because it is needed for planning and evaluating the efficaciousness of energy efficiency (EE) policies, programs, and measures for reducing emissions, especially in states opting to meet mass-based emission standards. Any credible claim of emission reduction should consider when the reduced consumption takes place and which EGUs are displaced. This may be important to present or future standards set by PUCs or air quality offices in some states and for meeting utility, grid congestion, and environmental goals. It may also be important in qualifying tradable credits of either ERCs or CO_2, in future voluntary and compliance markets.

Other Emissions and Other Sources

Although reduction of CO2 emissions from EGUs is the goal of the Clean Power Plan, the states' energy offices, air quality offices, and utility regulators have a related interest in reducing other pollutants from other sources. This Roadmap will be useful in converting avoided electric energy consumption from any program into reductions in other pollutant emissions as well as CO2. For example, EPA's Avoided Emissions and Generation Tool (AVERT) computes county-by-county displacements of sulfur dioxide (SO_2) and nitrogen oxides (NOx) annually (and during ozone seasons for NOx). State offices may wish to control and track reductions in particulate matter, heavy metals, and other energy-generation byproducts. Further analyses can also estimate water consumption impacts and savings. For purposes of the MEASURES project, however, this Roadmap report will focus on CO2 emission reductions from EGUs, as caused by ESPCs.

Goals of the Roadmap

This Roadmap is written with two goals in mind:

1. *Meeting the needs of electricity consumers at the lowest environmental and economic cost*: Energy efficiency measures are often a low cost means to meet demands for energy services. It is usually cheaper to improve efficiency to save a kilowatt-hour (kWh) to provide a given amount and quality of energy services (e.g., light, space conditioning, computing, cooking) than to supply additional kWhs to provide those services with less efficient equipment and buildings. The first goal of this Roadmap is to provide a guide for each state to measure, verify, track, record, and attribute the accomplishments of its ESPC-based electric energy efficiency efforts. The degree to which this first goal is achieved will be measured in MWh of reduced electrical energy

[7] Under the CPP state may either opt for rate (lbs CO2/MWh) or mass (tons CO2) based targets, which could include assignment, averaging, or trading of ERCs or CO2 emission allowances, respectively. This Roadmap can also be used in complement to CPP compliance or outside of the CPP context in support of state level energy and emission policies.

[8] EPA Proposed Model Trading Rule, 80 F.R. 64966 (Oct. 23, 2015) (to be codified at 40 C.F.R. Parts 60, 62, and 78)

consumption from ESPC activities that are designed to sustain (or improve) the meeting of each customer's needs.

2. As adherents to the three States' (VA, GA, KY) air quality standards and eventually to EPA's Clean Power Plan, the Energy Offices want to *minimize carbon dioxide and other emissions produced in meeting those consumer needs*. For that purpose, this Roadmap demonstrates methods for computing CO_2 emission reductions that result from electrical efficiency improvements,[9] in particular from ESPCs. The degree to which this second goal is achieved will be measured in tons[10] of reduced CO_2 emitted into the atmosphere through state-led performance contracting activity.

Each state's fleet of fossil-fuel-fired EGUs produces two things of interest to these goals: electrical energy supplied to the grid (measured in MWh), and CO2 emitted to the atmosphere (measured in tons). To satisfy a state's environmental and economic goals, one can either reduce the amount of energy needed to meet consumers' needs or produce the same amount of energy with less CO2 as a byproduct. The first can be done with ESPCs, among other "demand-side" means, and the metric is measured and verified MWh savings. The second can be done with any or all of three "supply-side" means, and the metric is tons of CO2 emitted per MWh generated.

The three supply-side means are:
1) improving the efficiency ("heat rate") of a state's fossil-fired EGUs;
2) dispatching more relatively efficient EGUs and fewer relatively inefficient EGUs to supply grid demand; and/or
3) bringing more low- or zero-emitting EGUs on line, such as renewable sources,[11] and low-emitting generation.

Both the demand-side and supply-side means reduce the release of CO2 and other unwanted generation byproducts into the atmosphere, for any state using fossil-fuel-fired power plants. Thus the two state goals are compatible with the EPA's Clean Power Plan.

Using the Clean Power Plan

EPA has published detailed emissions data from EGUs and software for mapping demand-reduction profiles against EGU dispatching profiles that states can use for planning their compliance with the CPP as well as to support meeting ambient air quality standards. Further, these tools can help states meet state level environmental objectives.

The goal of the CPP is to reduce CO2 emissions from existing EGUs. It offers flexibility in compliance plan design and implementation, offering states several major compliance paths, including the choice between:
(a) a "mass-based" target, which caps the total annual mass of CO_2 emitted by existing fossil

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[9] In this Roadmap, as in the CPP, "gross" savings are used; that is, without attempting to separate out the impacts that result from non-program influences, such as consumer self-motivation.
[10] The convention adopted by most U.S. practice, including the CPP, is to consider a "ton" equal to 2,000 pounds, often called a "short ton."
[11] At some stage of their development or use, renewable sources can add to emissions (biomass combustion, for example, emits CO2 but as a renewable resource can be done in a sustainable fashion). The CPP requires that use of biomass for compliance include analyses to show there will not be net adverse CO2 emissions resulting.

fueled EGUs meeting certain size criteria (nameplate capacity and % sales to the grid) and covered under the CPP in the state or
(b) a "rate-based" target, which caps the state's average ratio of CO_2 emitted to MWh generated by those EGUs.

All of the demand-side and supply-side means of meeting the states' goals reduce the total mass of CO_2 emitted by their fleet of fossil-fired EGUs, whether they make electricity by fossil-fuel-fired steam turbine or gas combustion turbine. This emitted mass is regularly monitored by EGUs and reported to state and federal air quality regulators, plant by plant, and its reduction is relatively simple to measure.

Supply-side means, such as heat-rate reduction and other generation improvements at the plant level, yield directly-measurable reductions in the rate of CO2 emitted per MWh of electric energy generated, reducing the average ratio for each state's fleet of fossil-fired EGUs. Since any demand-side means (including savings from ESPCs) reduces both the numerator and the denominator of that ratio, states need what EPA calls a "credit mechanism" to impact their rate-based target.

Credit Mechanisms and Tradable Emission Reduction Credits

Mass-based targets can be met by trading allowances among or within states that adopt that compliance path. The mass of CO_2 emitted by any plant is regularly monitored by state air regulators and the EPA, providing inter-state consistency and tradable units (tonnage-based allowances). For states that choose rate-based compliance, however, the calculation is not as obvious. Savings on the demand side have no impact on the average rate for each state, because the reduction in demand does not have a first-order impact on the efficiency (heat rate) of the state's fleet of EGUs.[12]

Therefore states that elect rate-based compliance must adopt a mechanism for crediting demand-side savings. The simplest and most intuitive mechanism is to add each MWh saved back into the denominator of the rate calculation. This reflects the logic that the state is meeting the needs of its consumers (Goal #1) with less generation. EPA suggests that each such MWh saved be considered an "emission rate credit" or ERC. [13]

Each MWh saved is 100% convertible into an ERC, provided acceptable M&V protocols have been adopted by the claiming state.[14] Trading of ERCs is also possible, but only among states that have adopted the rate-based compliance path (unless certain types of power-purchase agreements exist among them). Such trading will require mutual agreement on M&V procedures. It will be greatly facilitated by a regional or national registry of MWh savings (ERCs) and emission reductions (carbon offsets), which is the topic of Subtask 2.2. These considerations are reflected in the Roadmap, as described below.

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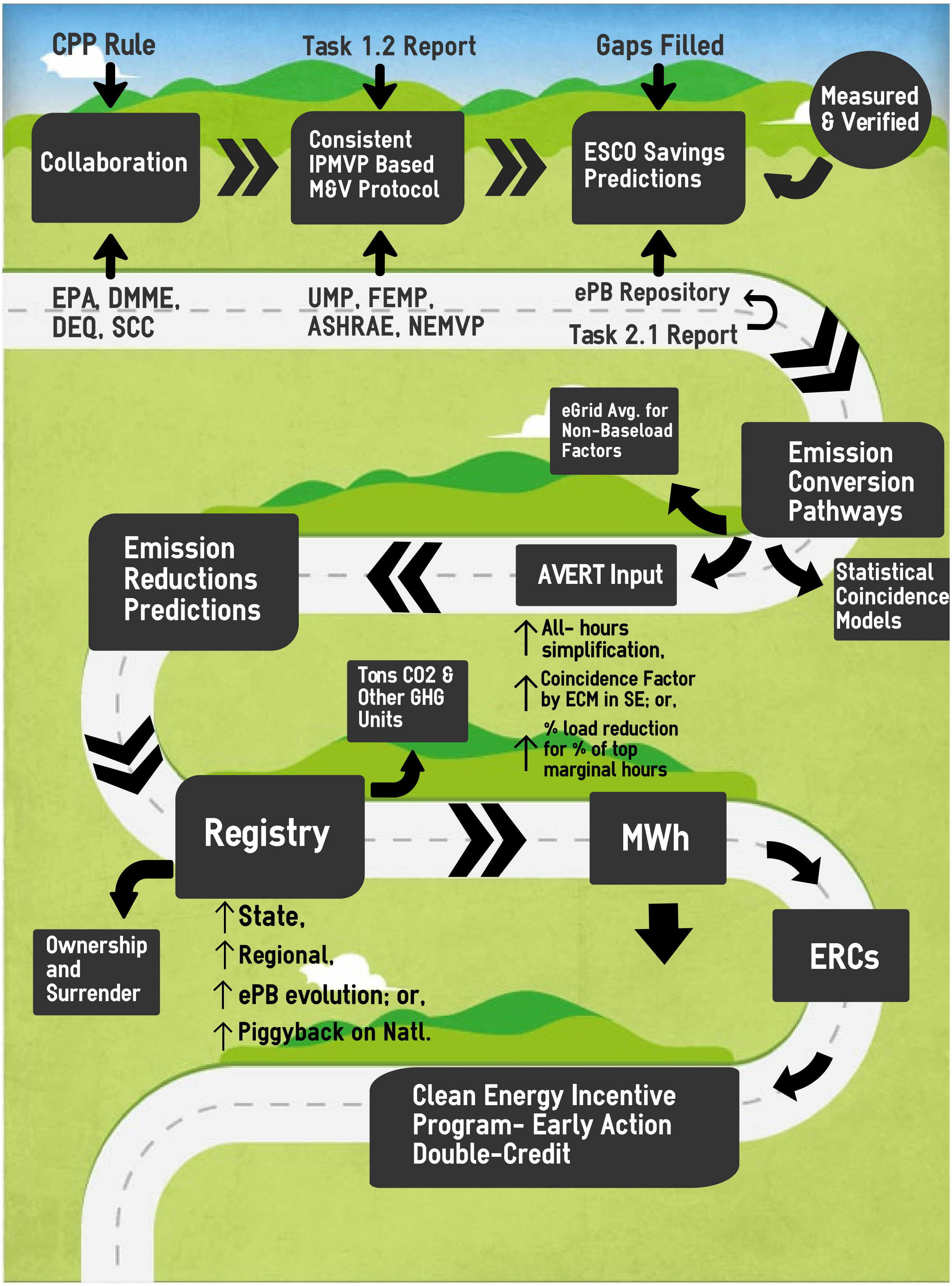
[12] There are second-order effects due to the probable impact of peak-hour demand reductions on dispatch order among EGUs, but those are relatively small and not considered in the CPP.
[13] See CPP Section VIII.K.1
[14] From an emissions viewpoint, some MWh savings are more effective than others, because of the mix of EGUs supplying the grid when those MWhs are in effect. The CPP does not make that distinction in its current definition of ERCs; it is, however, central to the conversion of avoided MWhs into avoided CO2 emissions.

The Roadmap

To meet the Goals defined above for the states, and to prepare a sound basis for trading credits and determining CPP compliance, a "roadmap" has been drafted. A graphic depiction of an actionable emission-reduction calculation roadmap is shown on the following page. It starts with a consensus EM&V protocol based on the International Performance Measurement and Verification Protocol (IPMVP), and leads to a regional or national registry of (a) electric energy savings which can be denominated in MWh (or "ERCs" for rate-based CPP compliance) and (b) CO_2 emission reductions which can be denominated in tons (for mass-based CPP compliance or carbon offset trading).


CPP Rule
Task 1.2 Report
Gaps Filled
Collaboration
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EPA, DMME, DEQ, SCC
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AVERT Input
Statistical Coincidence Models
All- hours simplification,
Coincidence Factor by ECM in SE; or,
% load reduction for % of top marginal hours
Tons CO2 & Other GHG Units
Registry
MWh
ERCs
Ownership and Surrender
State,
Regional,
ePB evolution; or,
Piggyback on Natl.
Clean Energy Incentive Program- Early Action Double-Credit

The following sections describe the various pathways through the Roadmap and refer to resource materials prepared to develop and test each step.

Collaboration

Collaboration between states and stakeholders has been identified as the first step in the "Emissions Reduction Calculation Roadmap." Briefly, key stakeholders that states may want to consult are: owners of affected electric generating units, utility and air quality regulators, renewable energy resource owners, energy efficiency program administrators, private sector energy service companies, environmental organizations, consumer advocates, regional EPA officials, and other relevant state agencies.[15]

States should also consult available resources related to compliance planning, such as the Regulatory Assistance Project's "12 Steps for Effective, Least-Cost Compliance," which provides: a) a basic process states can follow to achieve compliance goals, b) a comprehensive list of key stakeholders states should include in the planning process, and c) references to other compliance planning resources published by the National Association of State Utility Consumer Advocates (NASUCA), the National Association of Clean Air Agencies (NACAA), and the National Association of Regulatory Utility Commissioners (NARUC).[16]

Consistent IPMVP-based M&V Protocol

The Task 1.2 "cross-state" report on EM&V practices recommends consistent protocols and gap-filling steps, relying principally on IPMVP consensus. EPA provided draft guidance[17] on such EM&V approaches and protocols (and is currently accepting comments on that guidance), which would be prudent to consider for expediting CPP approval in the case of rate-based plans. The final CPP rule and the draft guidance document describe "presumptively approvable" templates and methods for twelve M&V topics.[18] The draft EM&V guidance largely draws from state-level and utility-level program EM&V practices. Unfortunately, this presents some difficulties for ESPC-level project M&V.

It is clear that EPA expects a thorough justification of the methods chosen to validate projected savings. Most of the "project-based M&V" discussion is consistent with IPMVP or DOE's Uniform Methods Project (UMP)[19] practice; however, several problems stand out:
a) The "common practice baseline" (CPB) definition on page 12 requires a dual baseline tied to remaining useful lifetimes in "early replacement activities" (which most energy conservation measures [ECMs] really are). This may demand substantially more equipment-level detail than ESCOs can gather at reasonable cost.
b) States must "justify why first-year independent factors can be shown to represent

[15] To see a full list of stakeholders states may want to consult, please refer to RAP's "12 Steps"
[16] These resources are intended to provide supplemental guidance to the Clean Power Plan final rule, Technical Support Documents (TSDs), and other EPA-issued guidance.
[17] EPA "Evaluation, Measurement & Verification (EM&V) Guidance for Demand-Side Energy Efficiency (EE)," Draft for Public Input. Aug. 3, 2015. Available online through the CPP Toolbox, EPA.gov.
[18] See pp. 7-8 and Appendices B and C of the EM&V Guidance Document. Section VIII.K.2 and VIII.K.3 of the Clean Power Plan discuss EM&V for demand-side EE programs.
[19] From Energy.Gov: "DOE aims to establish easy-to-follow protocols based on commonly accepted engineering and statistical methods for determining gross savings for a core set of commonly deployed energy efficiency measures."

standard/typical conditions over the life of the measure." (Page 18) While this seems a reasonable requirement, such justification for every ECM proposed may require more M&V effort than can be supported by the savings in some cases.
c) States may have to establish "a second set of calculations in addition to those used to establish and administer the contract between the provider and its customer." (pp. 34-35)
d) EM&V is required over the full lifetime of ECMs, or for the period in which an associated credit will be claimed. Most ESPCs have shorter durations, so the state may have to make provisions for post-contract persistence verification.
e) Appendix B, "Optional EM&V Plan Template for Demand-Side EE" (page B-1) is a "presumptively approvable" outline of a state's EM&V Plan. It is similar to plans developed by utilities and some state-level programs, but would be quite tedious to fill in for multiple ESPCs.
f) The level of detail required in (a-e) is not gathered under present eProjectBuilder (ePB) practice.
g) The requirement for "ex post" verification and ERC issuance adds risk to potential trading of future savings in present markets.

EPA invited comment on these draft guidelines.[20] Although as published the Draft M&V Guidance[21] presents difficulties for project-based M&V as listed above, the EPA paper does stay largely in agreement with IPMVP and does recognize the principle that EM&V costs should be a small fraction of the predicted savings. This is consistent with DOE's publications on this subject, as derived in the "Federal Energy Management Program (FEMP) – Uniform Methods Project (UMP) Comparison Paper"[22], which concludes that the primary M&V focus within ESPCs should continue to be based on owner- and ESCO-determined applications of FEMP and/or IPMVP, as the specific project requires. Both the FEMP and UMP guidelines explicitly and heavily rely on IPMVP.

In the context of this roadmap, all ESPCs conducted within a state over some specific period of time are considered to be a "program." Though this "program" may have some commonalities in states with common policies and regulations governing public ESPCs, each individual project is specified to meet differing circumstances with a differing mix of ECMs. In this way, there is no overarching set of "rules" all projects must follow. This is due to the unique ESPC relationship of the ESCO and facility owner, especially regarding the savings guarantee and how it is calculated. The task is to identify and promote, or perhaps mandate, that certain M&V practices become a part of every, or at least most, ESPCs conducted within a state.[23]

Selection and application of consistent EM&V practices is prerequisite to each state's adoption of ESPC "programs" that permit the creation of an accurate and sustainable database of ESPC project metrics. That can be achieved by formalizing the following practices, many of which are already being followed by the MEASURES states:

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[20] "The EPA invites the public and all interested stakeholders to comment on any aspect of the draft EM&V guidance; however, as the EPA works to finalize this document, the agency has particular interest in feedback on the following questions: . . .
- Is the guidance on important technical topics (e.g., common practice baselines, accuracy and reliability, verification) helpful, clearly presented, and sufficient/complete? Can this guidance be reasonably implemented, considering data availability, cost effectiveness, accuracy of results, and other factors?"
[21] M&V (Measurement and Verification) is used to denote the project or measure level, as opposed to EM&V, which generally refers to program or portfolio evaluation.
[22] Appendix A of the Project Team's Cross State EM&V Report titled "Development of a Consensus Approach for Energy Management and Evaluation of Energy-Saving Performance Contracts".
[23] This "program vs. project" distinction in EM&V practice is elaborated further in Appendix A of the report cited in footnote 11.

- *State oversight of ESPCs – to ensure consistent application of EM&V protocols.*
- *ESCO Prequalification – In addition to the typical prequalification process, to evaluate ESCO's ability and willingness to apply the necessary M&V and emphasize the need to do so.*
- *Annual Reporting in ePB gradually Required for all Projects – as part of the ESCO prequalification process and future proposal solicitations including attendance at ePB webinars if prior ePB project reporting cannot be demonstrated.*
- *Early Termination of Annual M&V Reporting Prohibited – both the "Owner" and the ESCO must be required to maintain a qualified M&V Plan for the duration of the useful life of the equipment being installed, unless they agree to forego the receipt of ERCs.*[24]
- *State review of Annual M&V Reports – to ensure consistency for the duration of each project's anticipated reporting period.*
- *State provision of technical assistance and ongoing M&V training – for not only state staff assigned to M&V review, but agency and local government staff who must review, approve and participate in ongoing M&V activities. Ongoing training is necessary, as staff turnover will occur during the CPP timeframe.*

Task 1.1 "EM&V Existing Practices,"[25] discusses the current legal authority in the MEASURES and other DOE ESPC Accelerator states to require certain M&V protocols for ESPC projects and provides guidance as to how states can structure their statutes or regulations to permit them to specify consistent CPP-recommended M&V protocols.

For purposes of this Roadmap, states are advised to pursue the consensus approach to EM&V developed under Task 1.2, while monitoring changes in the EPA Guidance.[26] Design of a Registry (pg. 12) will necessarily include a solution, since its validation and verification steps must satisfy both EPA and private markets.

ESCO Savings Predictions and eProjectBuilder (ePB) Repository

Given the timeframe for initial compliance with the CPP, there is ample opportunity for the MEASURES Project Team to continue (a) working with the ESCO industry in how to use ePB cost-effectively[27] and (b) guiding its evolution as a tool to support compliance with the CPP, since it is a work in process at Lawrence Berkeley National Laboratory (LBNL) and DOE.

Appendix A "ePB Interim Report" summarizes the Team's significant progress in assessing and suggesting corrections (as necessary) to ePB for use as a repository of critical project metrics.

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[24] The term of many ESPCs is shorter than the estimated effective lifetimes of some installed EE measures. To satisfy CPP, utility, and some trading requirements, "useful life" will require a flexible definition,or forego ERC claims beyond contract,or savings revert to project/property owner so long as they do requisite M&V.
[25] Appendix B of the Project Team's Cross State EM&V Report titled "Development of a Consensus Approach for Energy Management and Evaluation of Energy-Saving Performance Contracts".
[26] The States are considering submitting comments on the Draft Guidance, in response to EPA's invitation.
[27] As with EM&V requirements generally, a common industry reservation about ePB use is its cost relative to its benefit. One possible solution may be the allocation of some part of the future value of ERC and carbon credits to offset compliance costs.

Use of the ePB tool will be mandatory in FEMP programs and projects submitted by State Energy Offices of states participating in the DOE ESPC Accelerator commitments. Its data will contribute to, and draw from, the large national LBNL/NAESCO[28] database. This provides substantial benefits in benchmarking, marketing, reporting, internal credibility, contract administration, and standardization.

LBNL and DOE continue to expand ePB functionality, including recent decisions to add an M&V component and a CO2 emission-reduction repository. It is likely to evolve to be the least costly (to the states, but not necessarily to the ESCOs and their customers) and most efficient repository of project EM&V metrics. Virginia has already started testing ePB through the DOE ESPC Accelerator by inputting data for $75 million worth of projects to the database. Virginia is finding some passive resistance among the ESCOs, but that may be largely due to the fact that many of the projects were already developed prior to their being asked to enter project data in ePB.

Final commentary on ePB functionality and use will be delivered during Q6, in the context of Subtask 2.2, under which its contribution to tracking emission reductions will be evaluated and progress on its use by ESCOs summarized.

Emission Conversion Pathways

Once MWh reductions ("savings") have been measured and verified, they can be converted into CO_2 emission reductions. It is not possible to make an exact conversion, because the EGUs supplying the electric grid vary in both dispatch (when and to what extent they are connected and generating) and heat rate (how much and what kind of fuel is consumed per net MWh actually delivered to the grid).[29] One cannot predict these things precisely in the future, so estimations of CO_2 and other pollutants emitted per MWh generated must be based on recent experience. [30]

Fortunately, EPA collects and publishes data on generation and emissions of nearly all large EGUs connected to the U.S. grid, and on the dispatch practices of regional transmission organizations (RTOs) and other balancing authorities. The challenge is to put these two bodies of experience and data together and to "map" against them the time-varying impact of installed ECMs. Of particular interest is the grid-load impact of those ECMs likely to displace the load following and "peaking" EGUs dispatched during high-demand hours (which have generally higher emissions per generated MWh)[31]. Such displacements will usually eliminate more tons of CO_2 than reducing baseload EGU generation during lower-demand hours (spring and fall, nighttime, etc.).[32] So for example, ESPC dollars invested in an "economizer cycle" (that avoids chiller use during temperate hours) will save fewer tons of CO_2 than the same dollars invested in chiller

[28] National Association of Energy Services Companies

[29] There are also varying amounts of energy lost between the EGU and the end-use whose efficiency is being increased. This loss depends on distances, transformers and other things in the path, and can exceed 10%.

[30] The EGUs supplying the grid at any moment will include heavy emitters like coal-burning generators, more efficient fossil-fueled generators like combined-cycle gas, and essentially non-emitting generators like hydro, nuclear, and renewable plants. Their "dispatch order" is usually economically-driven, and their impact crosses state and regional boundaries.

[31] There are cases where an EGU dispatched for "peaking" may not emit more than baseload plants.

[32] EPA's Emissions & Generation Resource Integrated Database (eGRID) data for 2012 (most recent available) find that the U.S. annual CO_2 total output emission rate was 1,137 lb/MWh whereas the annual CO_2 non-baseload output emissions rate was 1,549 lb/MWh. EGRID2012 Data File accessible at http://www2.epa.gov/energy/egrid

efficiency upgrades (that removes more heat per MWh during all operating hours)—even if both saved the same amount of electrical energy.

This mapping of ECM load impacts against grid power sources can be modeled with reasonable accuracy, but cannot be predicted precisely. There are a number of approximations among which states can choose, however, depending on their balance of rigor and expense vs. simplicity and economy.

The simplest approach would be to use ESCO reports and investment-grade audits as the measure of MWh savings, and average historical tons of CO_2 per MWh in a given region as the measure of emission reductions.[33] This simple approach would ignore the variations on both the demand side (when is each ECM effective?) and the supply side (when are the heavier-emitting EGUs feeding the grid?). A more accurate method would be to use the regional "non-baseload" average CO_2 per MWh emissions factor that is readily available from EPA's Emissions & Generation Resource Integrated Database (eGRID). The non-baseload average emissions factor omits emissions from baseload units that operate irrespective of changing demand.

A more complex approach would be to match predicted hour-by-hour electric demand reductions from all energy-efficiency retrofits and replacements against predicted hour-by-hour emissions from all EGUs supplying the grid. This would require knowing what specific demand-reducing measures would be in effect over diurnal and seasonal variations. One could then enter the sum of the measures' impacts into hourly "bins" and map the results against the hourly EGU attributes mix expected on the grid. Accurate predictions are impossible, on both the demand and the supply side, but statistical models can and have been constructed, of varying degrees of rigor (the "Statistical Coincidence Models" Pathway). These tend to be proprietary, expensive, and difficult to use.

In response to this challenge and prospects for utility CO_2 emissions regulation (now the CPP), federal agencies, consultants, software developers, utilities and RTOs have proposed a number of relatively inexpensive, user-friendly, and reasonably accurate intermediate solutions. Two examples are EPA's aforementioned eGrid and AVERT. CESI staff have tested these models and prepared an analysis (Appendix B), which indicates that AVERT is accurate and user-friendly. EPA and DOE have endorsed AVERT and eGRID, although these models are no longer essential to the complying with the final CPP Rule.

AVERT Input Data Pathways

The AVERT model was developed in 2013 by Synapse Energy Economics, Inc.[34] for EPA and was first made available to the public in February 2014 after peer review and substantial beta testing. It accommodates complexities on both demand and supply sides of the modeling equation, allowing non-expert users to compute displaced emissions using relatively simple descriptions of energy efficiency programs. These descriptions can take several forms, leading to increasingly accurate AVERT outputs (see Appendix B). (AVERT does not attempt to model the input side of its simulations; i.e., the time-variant impacts of particular ECMs on grid load.)

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[33] In Virginia, for example, the DEQ computes this estimate annually, for in-state generation (e.g., 1,243 lb/MWh using 2006 data). Virginia, however, sits in two NERC sub-regions (mostly SERC but ECAR for the Western area), both including many "control areas" and characterized by large daily imports and exports of power. The power grid in Virginia therefore carries contributions from many out-of-state generators, in a mix depending on economically-driven dispatching by utilities and PJM.
[34] As a matter of disclosure, Synapse is a consultant to the authors.

As an input, AVERT will accept a description of ESPC–produced savings as simple as assuming that all the ECMs are effective during all hours, which might be approximately true for example with some industrial process efficiencies. A more accurate input (leading to more likely emission-reduction scenarios) would be to estimate the percent of the highest-demand hours that would be affected by the ECMs, and the percent reduction in demand they would produce during those hours. AVERT has an input template allowing such estimates. AVERT allows entry of actual or projected energy savings data down to the hour, allowing for daily, weekly, seasonal, and annual considerations of demand, generation, and emissions.

The most accurate input would be to compile all the ECMs implemented by ESCOs and describe (a) the load-reduction impact of each and (b) the hours (seasonally and daily) during which that impact would be felt (its hourly "coincidence factor"). Such data would give AVERT a very faithful representation of ESPC savings to work with, but would be true only for past or predicted impacts. One study that has attempted such a detailed representation is VEIC's Technical Reference Manual for the Mid-Atlantic States.[35] Such a TRM has not been compiled for Southeast states, but the VEIC data could be calibrated to Southeast conditions.[36]

Emission Reduction Predictions

The AVERT output, as described in Appendix B, is in both tabular and graphic form, the latter picturing where affected EGUs are located. This locational simulation would have been very important under EPA's Proposed CPP of 2014, but is not essential under the Final Rule, which greatly simplified rate-based "credits" for EE savings. (The Final Rule deals with in-state EGUs and in-state consumption, no longer attempting to associate avoided emissions with particular plants feeding the grid.) The quantitative output nevertheless provides as dependable a calculation of CO2 reductions as can reasonably be predicted with available data, and does so by state and county.

Registry of ERCs and CO2

Once electrical energy savings (in MWh) and avoided CO2 emission (in tons) have been computed from ESPC savings predictions in each state, those units must be registered and retired to make them tradable for value. The purposes of this accounting are to establish:

- Association and Certification – Each MWh of savings (avoided consumption) yields some mass of CO_2 emission avoidance, as computed by AVERT or other means.
- Attribution -- What is the source of each ERC and each ton—which State, program, ESCO, customer, year, and contract produced it? And who owns it?
- Identification -- Assigning a unique identifier to each ERC and ton, with its attribution, and entering it into a secure inventory.
- Issuance, Retirement, and Valuation-- If a unit's ownership is transferred for value (monetary or other), recording that value and the new ownership, and removing that unit from the inventory permanently.

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[35] Northeast Energy Efficiency Partnership, *Mid Atlantic Technical Reference Manual,* prepared by VEIC, May 2010

[36] Abby Fox from SEEA points out that Arkansas and TVA both have TRMs (although the former is stronger than the latter), but they don't necessarily use jurisdictionally specific data for determining coincidence factors.

Examples of new "owners" include EGUs under the CPP (for state credit), utilities subject to energy-efficiency portfolio standards (EEPS) or energy efficiency resource standard (EERS), private purchasers in a voluntary trading market, and purchasers who need the credit in a "compliance" (cap-and-trade) market. They may want to own units denominated in either ERCs (or simply MWh) or tons, depending on the program or market in which they operate. Under the CPP, for example, an EGU may want to purchase ERCs to add to its tons/MWh denominator (in a rate-based state) or tons of CO_2 to cover its emitted mass (in a mass-based state). A university or industrial firm may want to purchase "carbon-offset" tons to comply with a voluntarily-adopted goal, whereas a utility may want to purchase MWhs to help meet its EERS/EEPS [37]or other target.

The importance of a mechanism to retire such units derives from both public policy (to avoid double-counting) and private markets (to preserve the value of a limited supply). These objectives can be eroded when a certificate has not been properly identified as used or sold in one market, and therefore becomes available as an un-used certificate in either the same market or a different market. Emission or energy reductions associated with one certificate may be counted twice, which leads to distorted data, inaccurate reporting, and failed markets.

A state, regional, or national registry would provide a mechanism for all certificates, renewable-energy or energy-efficiency, to be qualified, validated, inventoried, issued, tracked, and retired.

The subject of Registry design is complex. A discussion of precedents, design, criteria, and needs is the subject of Task 2.2, with a "white paper" Milestone due in Quarter 6.

Registry Pathways

A Registry meeting these needs could be set up at the state, regional, or national level, or could evolve from the still-growing ePB design. Arguments for a state-level registry would include relative administrative simplicity and accommodation of political and market realities. Arguments for a 3-state or Southeast Regional registry would include economies of scale to keep administrative costs low, relative consistency to facilitate trading and streamline EM&V processes, and the progress being made under this DOE grant toward consensus in EM&V and the Roadmap that evolves.

A different option would be to "piggy-back" on efforts to set up a national Registry, for both CPP and private-market purposes. The Tennessee Department of Environment and Conservation's Office of Energy Programs was recently selected for a DOE state energy program competitive award to develop a roadmap for a national energy efficiency registry.[38] Additionally, one of this program's partners, the Southeast Energy Efficiency Alliance (SEEA), has proposed a national registry in conjunction with other experts in the field.[39] E4theFuture, a recently formed nonprofit successor to the Conservation Services Group, is now working on this proposal.[40]

A fourth option would be to expand the ePB program of DOE and LBNL to include EM&V and a national registry/tracking platform of ERCs plus a national registry with the functionality to be described in the Task 2.2 report. CESI and NASEO have been working with the ePB design team for over a year, testing ePB in practice and recommending improvements. Its eventual expansion

[37] EERS: Energy Efficiency Resource Standards; EEPS: Energy Efficiency Portfolio Standards.
[38] "State Energy Program 2015 Competitive Award Selections," Office of Energy Efficiency and Renewable Energy, Energy.gov, November 2015.
[39] The Climate Registry, "An Energy Efficiency Registry," September 1, 2014
[40] Discussion with Steve Cowell, CEO, Conservation Services Group, July 22, 2015.

to include a national registry would be challenging and require going beyond the present design concept, but would have the advantage of an existing team of experts with ongoing funding. [41]

Registry Outputs

The issuance and tracking of ERCs and tons of CO2 have been discussed in the preceding pages. With the registry's unique identifiers and retirement, these can be used for CPP compliance or sold into private or utility markets. Other emissions avoided by ESPC savings might also be tracked and traded via the registry (SO_2, NOx, particulate matter, methane, mercury), depending on the evolution of markets that could cover the cost of quantification.

The registry will record MWh of avoided consumption regardless of when its achievement is expected, since that is the present capability of affordable M&V protocols. In converting to CO2, however, the coincidence of ESPC hourly demand impacts with peak grid demand hours will be considered (by AVERT or other models). It is possible that a future CPP M&V Guidance provision could make that distinction, which would differentiate between coincident and non-coincident MWh, perhaps discounting ERCs from the latter.[42] Thus the Roadmap shows both ERCs and MWh as outputs.

Early Action CPP Credits

A special CPP provision is EPA's "double credit" for ERCs or equivalent allowances achieved early (during 2020 and 2021, the two years preceding the start of the interim compliance period) in low-income communities. This provision, collectively known as the "Clean Energy Incentive Program," will give participating states 2 credits per 1 MWh of avoided generation (in 2020-2021) as a result of demand-side EE programs implemented in low-income communities. To be eligible, states must have submitted a final state compliance plan and EE operations/RE construction must commence following the date when a state submits its plan.

Since EE projects generally produce savings with lifetimes well in excess of five years, efficiency improvements installed within the next year (assuming a state has submitted a final plan) would have a measureable impact during these "early compliance" years. A well-designed registry would support such trading of "futures," much like any other commodity that can be unambiguously defined and attributed.[43]

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[41] Note markets for SO2 and NOx already exist.

[42] The Registry should have the capability of being more rigorous than the current CPP specifications, in two respects. One distinction is between coincident and non-coincident MWh, important when computing avoided carbon emissions. AVERT takes that into account when converting to avoided tons of CO2, but so far the CPP does not observe that distinction in counting MWh – allowing each MWh of avoided electric energy consumption to be counted 100% as an ERC. To a utility or an ISO, however, a "peak-coincident ERC" may be more valuable than an undifferentiated ERC.

The second distinction is between net and gross "savings." Most utilities and utility regulators impose some kind of discount on savings for "free riders" (i.e., those that would achieve the savings anyway in the absence of the utility program). Again EPA has ignored that (in this case explicitly), allowing gross savings to be considered 100% convertible to ERCs. Therefore a gross, non-coincident MWh may be less valuable in some markets than a net MWh during peak-demand hours.

[43] EPA's current edition of M&V Guidelines relies largely on "ex post" verification, which would make futures trading problematic, but this may be relaxed.

Appendix A
ePB Interim Report

[Note: CESI's review of eProjectBuilder (ePB) is ongoing because LBNL and DOE continue to expand the ePB functionality, including recent decisions to add an M&V component and a CO2 emission-reduction repository. Thus this report describes our analyses and recommendations completed to date. It is our intention to continue support of the designers as ePB evolves.]

In January 2015, CESI circulated to the MEASURES project team "Preliminary Comments on the Use of ePB in Standardizing M&V among States' ESPCs." That document summarized the capabilities, outputs, benefits, and use of the online "eProjectBuilder" tracking software developed by the Lawrence Berkeley National Laboratory (LBNL) with DOE and input from the ESCO industry. It was prepared, and the software subsequently tested, in collaboration with LBNL designers of the tool. Since then ePB has been modified and expanded. As a result, we provide here an update of the preliminary report on ePB utilization, and draw some early conclusions on its ultimate use (including its evolution toward a Carbon Emission-Reduction Registry).

This Interim Report summarizes our findings to date, to be shared with the Project Team, LBNL, and ESCO practitioners. Final commentary on ePB functionality and use will be delivered during Q6, in the context of Subtask 2.2, under which its contribution to tracking emission reductions will be evaluated and progress on its use by ESCOs summarized.

Use of the ePB tool will be mandatory in FEMP programs for federal performance contracts. ePB use will also be required for projects submitted by state energy offices participating in the DOE ESPC Accelerator. Its data will contribute to, and draw from, the large national LBNL/NAESCO database. This provides substantial benefits in benchmarking, marketing, reporting, internal credibility, contract administration, and standardization, as listed in the previous report.

Design and Purposes of the ePB Test

In February 2015, CESI tested ePB with data from an actual ESCO project entered by an experienced ESPC developer to determine time requirements and any difficulties of use, and to judge its value and applicability to the tracking of ESPC performance and emission reductions. The test evaluated ePB as a potential component of a registry of ESPC energy savings and carbon emissions reductions in government owned buildings in Virginia, Kentucky and Georgia. In order to streamline their ESPC programs and expand the ESPC state, local, and private markets, these states recognize the need to pilot and adopt an ESPC project tracking system. LBNL provided test access to the ePB database and assisted CESI as necessary as the data template was filled in and uploaded.

The test involved the entry of sample project data by a CESI staff member who previously developed ESPC projects for a national ESCO. The project data were from an actual public housing ESPC developed and completed several years ago. The data were drawn directly from project development spreadsheets and schedules that most, if not all, ESCOs would typically create for any project. The completed project had multiple sites, buildings and ECMs. It took approximately four hours to enter all of the required data ePB inputs and approximately 50% of the non-required inputs. The test could not realistically mimic an actual project in development during which there would likely be one or two iterations of the initial project entries as the Owner and ESCO agree on the final project scope, savings and cost. Those iterations could add 2 hours to the ESCO effort.

For purposes of this test, CESI assumed the roles of both “Project Initiator” (the customer) and ESCO (the contractor), which would normally be separated in practice.

The requested supporting documentation was not uploaded during the test. The major “supporting” documents requested are broadly defined in two footnotes to ePB Schedule 2 “Implementation Price by ECM”:

> (3) Contractor shall attach adequate supporting information detailing total implementation expenses.
>
> (4) Attached supporting information shall be presented to identify portions of ECM or project expenses included in proposed bonded amount.

This information is typically produced by an ESCO as part of project development, but may require editing before submitting to ePB. The amount of time required will vary from project to project, but on average would likely add 2 hours to the eBP uploading effort.

As a result of the test and our collaboration with LBNL, we recommend that future ESPCs use ePB in support of registering savings and other data in the national database, allowing convenient benchmarking for the 3 states.

The ePB Project Data Entry Process

Project Initiation - CESI, as the customer (“Project Initiator”) initiated a new project on the ePB website. The initiation process is quick and straightforward, taking less than ½ hour. Only basic project information is required (Project Name, Market Segment [from ePB drop-down menu, or “other”], zip code and email address of ESCO project contact).

Data entry – Once the project is initiated, the ESCO may gain access to the project template for data entry. CESI, as the ESCO, downloaded the MS Excel-based ePB data template and entered project data into most, but not all of the approximately 140 input cells across seven MS Excel worksheets that make up the data template. The requested data included in the ePB system are, with one notable exception (the baseline use by ECM), what would typically be found in the technical and financial schedules of an investment-grade audit.

The Project Initiator may discuss and agree to the project data entries with the ESCO and accept them contractually prior to uploading the project data, or the project information can be uploaded, reviewed by the Initiator and edited as necessary by the ESCO to create a final accepted project. Only authorized users will be able to review individual project information. When the ESCO submits a project, the project data fields are “locked” from further editing by the ESCO (only the Initiator can unlock a particular project for changes). [44]

The data template currently contains seven Excel worksheets. Most fields are intuitive; in addition, there is a helpful list of definitions following the template in the data template guide and online videos guiding users through the entire ePB data entry/upload process (available on

[44] During the ePB test with LBNL, CESI was able to log in as both an ESCO and a Project Initiator.

the ePB Help/Documentation page). Template field titles in red font indicate “required” cell entries.

The “Summary Schedule” sheet contains only 12 required single cell inputs which request basic project identification information readily available to the ESCO. All cells were easily filled in by CESI.

The “Annual Escalation Rates” sheet has no “required” inputs, but does allow for varying real unit escalation rate estimates for each commodity purchased, agreed upon M&V services annual cost inflation and real and/or inflationary O&M costs/savings for each year of the project repayment term. Details supporting the entered rates are not requested by ePB.

Schedule 1 “Cost Savings and Payments” contains 3 required input cells asking for Implementation Period information (Estimated Cost Savings, Guaranteed Savings and Payments [by Customer] during the period). It is not clear if the payments are intended to be advance debt service payments, cash cost contributions, etc. CESI entered a zero for Guaranteed Savings and Payments in the implementation period and the ePB software accepted that input. The remainder of this Schedule is locked to the ESCO as ePB calculates annual total savings, guaranteed savings and payments for each repayment year, all based on other ESCO inputs in other Schedules.

Schedule 2 – Implementation Price by ECM

Only 4 fields are required to establish an ECM in Schedule 2 Implementation Price by ECM:

Technology Category;

ECM description;

Implementation direct cost; and

Project implementation markup (one for the entire project).

For Technology Category, the tool lists and assigns code numbers to about 70 of the most common measures in 20 technology categories, with each category containing an “other” line for less common technologies. This allows each project/contract entered to be included within the standardized national ePB database and can provide critical insight into potential project CO2 emissions reductions. [45]

Schedule 3 - Performance Period Cash Flow

This schedule has only two required entries: First Year M&V cost and the annual performance period expenses escalation rate. There are several non-required entries, but the majority of this schedule’s cells contain ePB formulas that calculate the project cash flow, including annual debt service payments, based on other required ESCO entries.[46]

Schedule 4 – First Year Estimated Cost Savings by ECM

[45] The calculation of emission reductions, however, requires a more sophisticated mapping of demand-reduction profiles against grid-connected generators as dispatched, which is the subject of a separate paper.

[46] DOE and LBNL are working on an M&V augmentation of ePB, expected to be available before the end of this grant period.

This schedule automatically calculates savings (in energy and dollars), based again on ESCO inputs --converting kWh, therms, etc. as entered per ECM to MMBtu, and escalating ESCO-entered first-year dollar savings at the rate(s) entered by the ESCO. It then computes annual payments and the contract term; and reports estimated and guaranteed savings for each year of the contract term. All these calculations are based on ESCO-entered project data—including implementation cost and savings estimates by measure, project-level markups, financing terms, and other key information.

Schedule 5 – Cancellation Ceilings (if applicable)

This schedule is only used if the proposed Energy Services Agreement has a Cancellation Schedule and is not a required entry in any case.

Uploading the Completed Template to ePB

Uploading the completed template to ePB is relatively easy. However, when ePB indicated that the ECM section was only 91% complete, it was difficult to figure out exactly what information was missing. Most of the data prompts showed that a value was already entered in the displayed cell. As LBNL explained, most of the checks for required fields happen after the data gets uploaded into the ePB system, not in the data template. As a result of the test, they recognize the need to ensure that this check happens at the template level and will address that in the future versions.

It was determined that the 9% incomplete was due to ECMs with missing cost/savings in the data template. These ECMs were deliberately entered by CESI to represent ECMs analyzed by the ESCO in the Investment Grade Audit (IGA) that were not currently included in the project scope but might be added by the Customer as the project is finalized. As LBNL explained if an ECM is to be retained as a placeholder in the interim before the customer decides, a zero should be entered in implementation costs to get the ECM section to “100% complete.”

When the project is finalized, the ESCO must either enter the actual costs and savings for the ECM or delete it, depending on what the customer decides. Otherwise the ECMs are going to show up on the output schedules even though they do not have any associated costs or savings. The ECMs can be removed from ePB when the project is finalized, and the ESCO can keep the complete working version of the template in case other test scenarios are desired in the future.

Measurement and Verification (M&V)

ePB intends to add an M&V component in 2015 (which will, of course, still rely on ESCOs entering their calculations). Some calculations to measure savings could be easily built into the program (e.g., lighting change-outs), but others would be difficult to incorporate (e.g., modulation of chilled water temperature with load). The tool will not verify savings, in that it does not specify metering, model building performance, or perform custom calculations. It does require the ESCO to identify the IPMVP “option” being used for measurement. Additional data input may be required to take advantage of the new ePB M&V component.

In April of 2015, two CESI staff members participated by request in an LBNL M&V Module survey asking for feedback on which data fields are most critical in constructing an M&V database.

CESI Discussions and Correspondence with LBNL

LBNL provided online access to ePB to CESI in December of 2014. As the above testing took place, numerous emails were exchanged. Initially, the discussion centered on potential problems with email access, including browser compatibility, assignment of “fake” email accounts for the “owner” so CESI could access ePB as the ESCO, and other minor access issues that were all favorably resolved.

Discussion of issues then progressed to how to properly fill in each required entry, why ePB might calculate an “incomplete” project even though it appears that all data has been provided, the need for ePB to provide more specific definitions of certain inputs, such as baseline data for each ECM requested in Schedule 4, and how ePB preforms the default calculation of project term and interest rate (if the ESCO does not enter this information). On this last point, LBNL pointed out that ePB can provide a blank template so the ESCO can override the template defaults.

CESI made several recommendations to request certain data by specific ECM, so that ePB can potentially be used as the basis of emission reduction calculations and a carbon registry. We subsequently agreed that these inputs are better placed in the upcoming M&V component.

The email exchange resulted in a list of specific template improvements summarized in CESI’s “Comments / Suggestions for Improving the ePB Template.”

Answers to ePB Questions in the MEASURES Questionnaire

For Virginia, two of the three ESCO respondents indicated familiarity with ePB, but were not sure if they could reasonably provide the required inputs for their projects. For Kentucky, one of three ESCO respondents indicated familiarity with ePB. The other three were not familiar with it. For Georgia, all four ESCO respondents were not familiar with ePB. The team is attempting to determine if this general lack of familiarity is more a function of the individual respondent’s lack of exposure to ePB as opposed to other ESCO staff who may be familiar but were not asked to, or declined to, fill out a questionnaire. This may very well be true for VA and KY, whereas, GA has really not yet introduced ePB to their ESCOs.

In the Virginia expert interview, Charlie Barksdale, DMME’s Utilities and Performance Contracting Manager, said: “They [the ESCOs] report info to us on a quarterly basis but with the implementation of eProjectBuilder we may have the information available to us anytime we need to access it. This depends on the ESCOs keeping the info current and, if we are going to use it, it should be made mandatory if they are on the contract [ESPC].”

As part of Virginia’s participation in the DOE ESPC Accelerator, DMME staff with assistance from LBNL, reviewed the ePB template online and made numerous contacts with ESCOs operating in Virginia to get them to start to enter data in ePB. Some ESCO’s have been more cooperative than others with several entering at least one sample project in the database. The recent FEMP requirement to use ePB for federal projects should at least make ePB more familiar to certain ESCO staff, at least those who operate in the federal market. DMME staff will continue to work with ESCOs to improve the compliance rate.

Appendix B
eGRID/AVERT Analysis

Introduction

An objective of Task 2.2 is to recommend an accurate, valid analytic method for determining the quantity of CO2 emissions reduced by the various ECMs an ESCO may install as part of an ESPC. This Interim Report discusses the testing and evaluation of "AVERT" (AVoided Emissions and geneRation Tool) as an acceptable method. Published in 2013 by Synapse Energy Economics, Inc. "AVERT" was first made available to the public in February 2014 after peer review, substantial beta testing and review by the EPA.

The Virginia Department of Environmental Quality (DEQ) has stated "While there are numerous methods to estimate GHG emission reductions from avoided generation, we believe that the EPA AVERT tool is a good choice for this purpose as its results should be readily accepted by the EPA if and when we choose to take "credit" for these efforts."[47]

AVERT accommodates the complexities on both the demand and supply sides of the modeling equation, allowing non-expert users to compute emission reductions by use of readily-available descriptions of energy efficiency and renewable energy programs. It is therefore worthy of consideration as a tool for converting verified electricity savings into predicted CO_2 emission reductions for Virginia and its partner states.

While an ESPC will often also address natural gas and fuel oil savings as well as possible switching of fuels (e.g., fuel oil to natural gas), the carbon reductions created by these fuel use and emissions reductions are dependent on the efficiency of pre- and post-project equipment, controls, and other measures and should be calculated on that basis. It is anticipated that those calculations will evolve from the ESCOs M&V protocols as entered in eProjectBuilder (ePB), or some other tracking system, and the resulting carbon reductions can be included in the carbon registry (separating out electricity savings for CPP purposes). Any inherent increases or decreases in electricity use that arise from these ECMs can be entered into AVERT, if the data is entered correctly into the model.

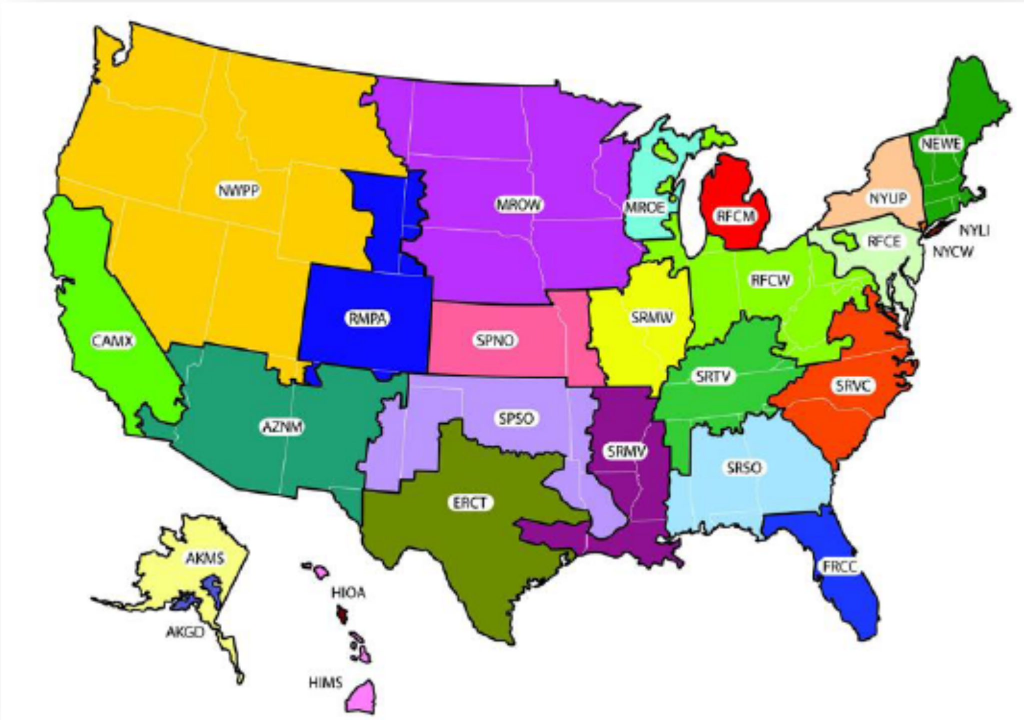
An important resource for understanding the various approaches to electricity carbon reductions calculations is the EPA's "Roadmap for Incorporating Energy Efficiency/Renewable Energy Policies and Programs into State and Tribal Implementation Plans, Appendix I: Methods for Quantifying Energy Efficiency and Renewable Energy Emission Reductions. App. I, page 19, references the EPA Clean Energy Resources eGRID annual average emissions data: (http://www.epa.gov/cleanenergy/energy-resources/eGRID/index.html). According to the EPA "... (eGRID) is a comprehensive source of data on the environmental characteristics of almost all

[47] 1-26-15 email from Thomas R. Ballou, Director, Office of Air Data Analysis & Planning,Virginia Department of Environmental Quality.

electric power generated in the United States. These environmental characteristics include: air emissions for nitrogen oxides, sulfur dioxide, carbon dioxide, methane, and nitrous oxide…"

As indicated in the table, the eGRID output is indicative of "regional average non-baseload emissions" reductions. As an average, it does not represent the marginal (hour-by-hour) peak load emissions reduction rates for specific ECM types or groups.

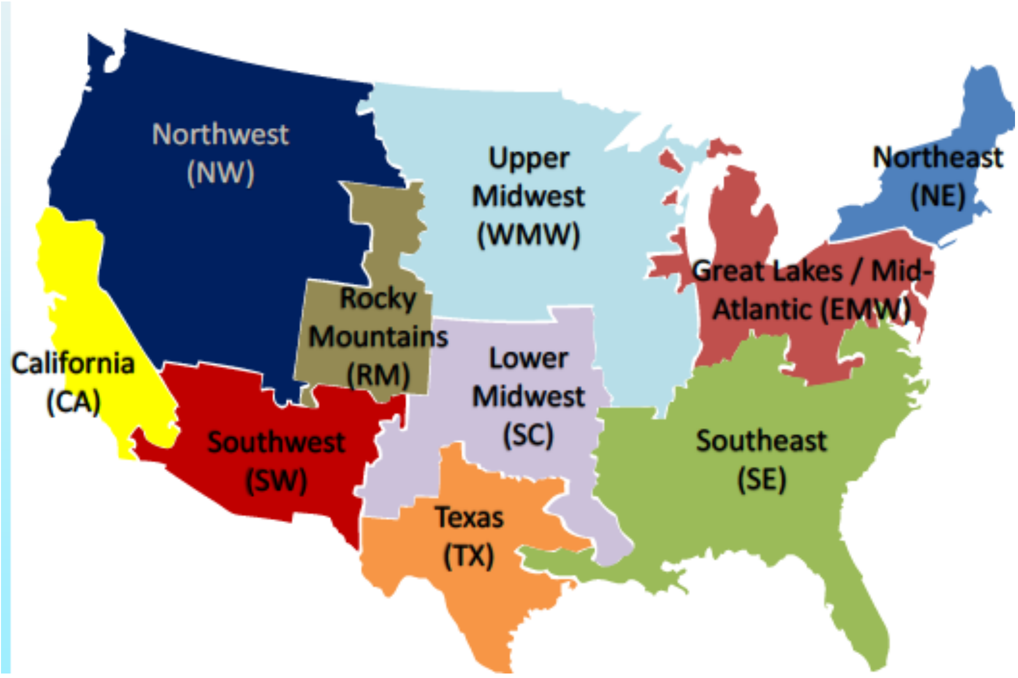
The eGRID regions are geographically grouped by the EPA as shown in this map:



Source:
http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2010V1_1_year07_SummaryTables.pdf>

The three states in the MEASURES grant are split up between four eGRID regions: Virginia is split between "SRVC" and "RFCW"; Kentucky is in "SRTV" and Georgia is in "SRSO."

In contrast to the eGRID, the AVERT regional map below shows that all three MEASURES states are in same Southeast Regional Database (95% of Virginia, and 91% of Kentucky and 100% of Georgia), which means one AVERT emissions reduction model run can simultaneously accommodate ECMs in aggregate across all three, in addition to yielding more accurate results than eGRID could provide. The magnitude of potential variance is illustrated in the below test evaluation comparison of the level of reductions estimated by both analytic approaches.



Several Input options are available in AVERT's Step 2:

Enter EE impacts based on the % reduction of regional fossil load		
Reduce generation by a percent in some or all hours		
Apply reduction to top X% hours:	0%	% of top hours
Reduction % in top X% of hours:	0.0%	% reduction
And/or enter EE impacts distributed evenly throughout the year		
Reduce generation by annual GWh:	161.3	GWh
OR		
Reduce each hour by constant MW:	0.0	MW
And/or enter annual capacity of RE resources		
Wind Capacity:	0	MW
Utility Solar PV Capacity:	0	MW
Rooftop Solar PV Capacity:	0	MW

The user can enter EE impacts as percent reductions to a percent of top hours, annually by GWh reduction, reduction of each hour by a constant MW, or, for renewable energy resources, annual MW capacity of Wind, Utility Solar PV, or Rooftop Solar PV.[48] Although AVERT was designed for

[48] See the "AVERT Overview and Training Manual" for a more detailed explanation of each impact option.

program-level magnitude of energy reductions, these options provide adequate adaptability to most typical comprehensive ESPC projects, especially if project data is aggregated across many ESPCs.

AVERT Test Process and Data Entry

AVERT is Excel-based with Visual Basic macros for Microsoft PC use. As the test progressed, CESI was able to edit the Visual Basic code such that AVERT macros would also execute on Apple/Mac products.

The seven megabyte AVERT module template is free for download on EPA (http://www3.epa.gov/avert/) and Synapse websites (http://synapse-energy.com/tools/avoided-emissions-and-generation-tool-avert). Once a regional database (the Southeast in this test) is selected for upload to the module, it expands to approximately 60 megabytes. When just one Impact Option is selected (annual GWh in the test) and the module computes the avoided emissions, it further expanded to 300 megabytes. Multiple module runs will require significant hard drive capacity. In spite of the file size, the resulting output files are available for download and review, but the actual backup calculations are not retained and not reviewable by the user.

Two Tests of AVERT

Test #1

CESI selected “Reduce generation by annual GWh” for simplicity and as a reasonable comparison to the eGRID annual average data. Using DMME’s VEMP EPC electricity reductions for ESCO-reported projects completed in 2013, we entered 161 GWh annually and assumed that all electricity reductions were coincident with every hour of marginal non-baseload generation for the entire year. We then uploaded AVERT’s Southeast database for 2013.

AVERT Regional Displacement Results

Southeast, 2013 AVERT

Output: Annual Regional Displacements

Click here to return to Step 4: Display Outputs

	Original	Post-EERE	Impacts
Generation (MWh)	774,484,400	774,323,600	-160,800
Total Emissions			
SO_2 (lbs)	1,757,262,300	1,756,926,500	-335,700
NO_x (lbs)	882,301,100	882,135,700	-165,400
CO_2 (tons)	594,878,600	594,769,400	-109,100
Emission Rates			
SO_2 (lbs/MWh)	2.269	2.269	
NO_x (lbs/MWh)	1.139	1.139	
CO_2 (tons/MWh)	0.768	0.768	

Negative numbers indicate displaced generation and emissions.
All results are rounded to the nearest hundred. A dash ("—") indicates a result greater than zero, but lower than the level of reportable significance.

AVERT calculated a regional CO2 displacement of 109,100 tons.

AVERT also provides an output map showing the locations and intensity of regional displacements so one can see exactly where the marginal emissions reductions are occurring.

The test map shows the following dispersion, with much of the reduction in states in the region (especially North Carolina) other than the three MEASURES states (33% in MEASURES states and the remainder in other states in the region):

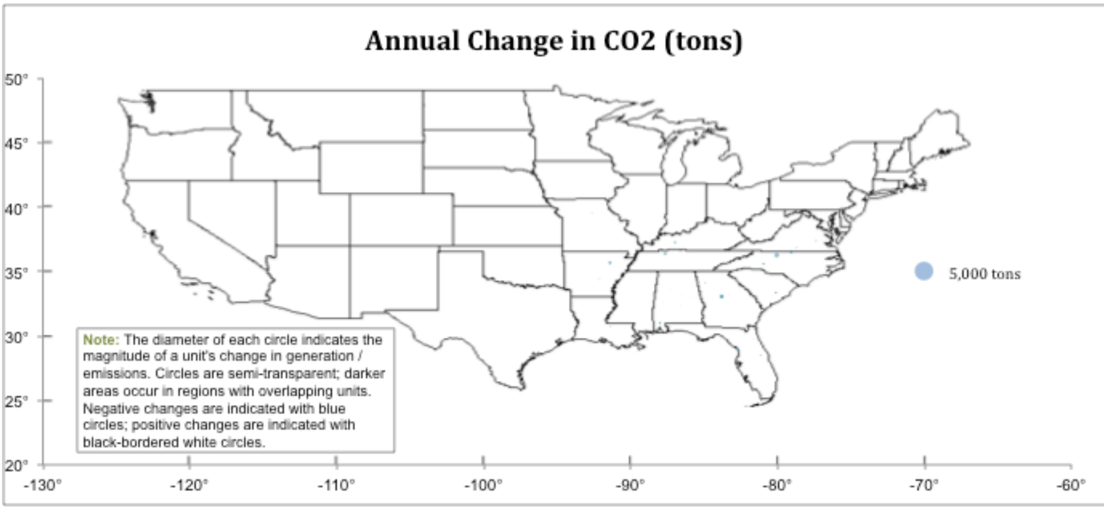


Exhibit A is AVERT's output of, "Annual Displacement Data by County," which lists the Southeast region emissions reductions breakdown state-by-state, county-by-county. The output data is of course imperfect, dependent on past dispatch practices and other assumptions, but it is based on a fairly sophisticated model endorsed by EPA and is accessible to non-expert users.

Comparison of AVERT to eGRID

In this test, AVERT's CO2 displacement result is about four times greater than the 24,000+ ton eGRID-based estimate derived by applying the eGRID annual average CO2 value for the eGRID region Virginia is in (using the eGRID 2010 values which is the last year available). The 2013 electric system (as modeled in AVERT) and the 2010 data from eGRID likely differ to some extent though probably not enough to account for the difference. An eGRID "non-baseload" average computation might yield CO2 displacement numbers closer to the AVERT test.

The AVERT Users Manual contains the following instruction for entering the annual GWh impact value:

"You may have an estimate of the total amount of energy that is targeted or required to be reduced by a program in a given year, but lack information about the distribution of those reductions over the course of the year. "Reduce generation by annual GWh" simply distributes those savings evenly over all hours of the year. The user inputs a total number of GWh expected to be saved in a single year. This may be a highly erroneous assumption if savings are targeted from residential or commercial customers, for whom energy efficiency measures tend to target peak use reductions. However, an industrial or refrigeration efficiency program may be well represented by a constant reduction across most hours of the year. Use this option with close attention to the types of programs assumed in your analysis."

The DMME ESPC database currently does not include enough detail regarding the actual ECM mix in EPC projects to allow us to enter the appropriate impact values in the various categories available in AVERT. The anticipated use of eProjectBuilder (ePB), or some other tracking system, may allow the AVERT user to enter more detailed data in the impact categories, thereby yielding a more accurate assessment of reductions at the margin. In any event, if AVERT is applied correctly it should always yield a more accurate assessment of emissions reductions than an eGRID averaging method.

In an email exchange on this topic between CESI and Synapse Energy, Synapse affirmed "eGRID is looking for "*average annual value* for the region Virginia is in. AVERT (and most modeling approaches) are seeking to estimate the marginal emissions...not the average."

Test #2

In this test, CESI analyzed six years of anonymous ESPC project- and ECM-level cost, square foot and electricity savings data provided to CESI by NAESCO and LBNL. Three markets were included in the data set: K-12 schools, local government buildings and college/university facilities. Three ECM categories were represented: sixteen projects involved only lighting improvements; 343 major HVAC improvements; and 116 minor HVAC improvements. From the data we calculated several national average values: an investment of $5.25/sq.ft. (in 2012 dollars) and 2.86 kWh saved per sq.ft.. These values were also calculated for each of the three ECM sub-categories.

We then performed a "what-if" exercise in which we assumed a first-year 3-state total EPC investment of $200 million. Applying the derived national factors to that level of investment yielded a total of 108,907 MWh saved. Of that, the proportion of "lighting" savings derived from NAESCO data is about 2% of the total, or 3.4 GWh. Marginal representations of these kWh savings values were then entered in the AVERT model as follows:

Enter EE impacts based on the % reduction of regional fossil load

Reduce generation by a percent in some or all hours		
Apply reduction to top X% hours:	1%	% of top hours
Reduction % in top X% of hours:	0.5%	% reduction

And/or enter EE impacts distributed evenly throughout the year

Reduce generation by annual GWh:	3.4	GWh
OR		
Reduce each hour by constant MW:	0.0	MW

And/or enter annual capacity of RE resources

Wind Capacity:	0	MW
Utility Solar PV Capacity:	0	MW
Rooftop Solar PV Capacity:	0	MW

The 3.4 GWh lighting savings is entered as an annual GWh reduction. One must then recognize that the remaining 105,400 MWh (mostly from major HVAC) is the upper limit of potential MWh savings both at the generation margin, since that is the total annual savings predicted by the

ESCOs. We then backed into a reasonable marginal MWh reduction by iterating the "% of top hours" and "% reduction in the top hour," in several AVERT model runs. One result is 1% of top hours and .5% reduction in that top hour. The AVERT output looks like this:

	Original	Post-EERE	Impacts
Generation (MWh)	778,932,000	778,865,300	-66,700
Total Emissions			
SO_2 (lbs)	1,700,627,700	1,700,374,900	-252,800
NO_x (lbs)	820,429,100	820,328,700	-100,400
CO_2 (tons)	597,909,100	597,894,400	-14,600
Emission Rates			
SO_2 (lbs/MWh)	2.183	2.183	
NO_x (lbs/MWh)	1.053	1.053	
CO_2 (tons/MWh)	0.768	0.768	

This 66,700 MWh generation reduction (which includes the 3.4GWh) indicates that about 2/3rds of the total MWh savings occurred at the margin. The test illustrates that a $200 million annual ESPC investment may provide savings somewhat noticeable against the Southeast region total. Of course, the EPCs from following years would add to that reduction. It also illustrates that the upper limit of gross CO_2 emissions reductions for $200 million invested is about 22,000 tons (1.33 times the 14,600 tons calculated by AVERT in the Impact/CO_2 row above). This is based on the AVERT 2013 Southeast database, which that introduces a degree of error as well.

As the MEASURES tasks proceed, CESI will continue to track other studies and technical resource manuals like VEIC's 2010 Mid-Atlantic Technical Reference Manual[49] to increase accuracy of aggregated ECM MWh AVERT inputs for the Southeast region.

Another potentially valuable AVERT output is "Annual Displacement by County," which breaks down the calculated emissions reductions by county in each state in the region. It can be used by each state to define the CO_2 emissions reductions for this savings scenario that occur within the geographic boundaries of the state.

AVERT limitations: AVERT does have some geographic and temporal limitations that need to be accounted for, as pointed out in email correspondence from a Kentucky MEASURES' team

[49] www.neep.org

member (Exhibit B). If we imagine a state that produced within its borders all of its powers from a single source and imported none, we could be confident of the CO_2 emission reductions from its EE. However, as soon as the local dispatching starts to admit more than a single source, one has to consider both how those sources are brought on line at the margins and how EE measures themselves affect load over time. The AVERT model had to make some more realistic--but imperfect--assumptions. One could make better models (e.g., looking at local dispatching at the margins and individual ECM profiles), and some modelers have done that, but they become increasingly difficult to use. If the CPP is implemented, an advantage of AVERT is that EPA has already approved it. AVERT updates regional mixes annually, but one still would have to discount the impact of early years' calculations. Also, the impact of installed ECMs will likely change over time.

AVERT does allow for user modification of the preset regional databases such that one could delete a generation asset if one knew it was off-line or coming off line in the near future.

Our test results support AVERT as a model that would allow non-expert users to compute marginal emission reductions quickly, accurately and at a reasonable cost. It is worthy of consideration as a tool for converting verified electricity savings into predicted CO2 emission reductions for Virginia and its partner states.

Conclusion

Our test results support AVERT as a model that would allow non-expert users to compute marginal emission reductions quickly, accurately and at a reasonable cost. It is worthy of consideration as a tool for converting verified electricity savings into predicted CO_2 emission reductions for Virginia and its partner states.

Exhibit A - “AVERT Annual Displacement Data by County”

Output: Annual Displacement Data by County

State	County	Peak Gross Generation, Post-EERE (MW)	Annual Gross Generation, Post-EERE (MWh)	Annual Displaced Generation (MWh)	Annual Displaced SO2 (lbs)	Annual Displaced NOx (lbs)	Annual Displaced CO2 (tons)	Annual Displaced Heat Input (MMBtu)	Ozone Season Displaced SO2 (lbs)	Ozone Season Displaced NOx (lbs)
GA	Bartow	3,179	17,098,600	1,600	1,800	1,000	1,600	1,600	1,600	700
GA	Chatham	141	653,000	-400	-4,600	-1,600	-300	-300	-3,100	-1,100
GA	Cobb	2,390	17,225,400	2,900	ñ	ñ	1,000	1,000	ñ	ñ
GA	Coweta	688	825,400	-2,100	-43,400	-7,000	-2,100	-2,100	-30,800	-5,000
GA	Dougherty	62	87,300	ñ	-1,500	-500	-100	-100	-700	-200
GA	Effingham	1,965	8,840,200	-1,000	-4,700	-3,200	-300	-300	-3,500	-1,900
GA	Floyd	441	1,013,400	-900	-1,300	-1,500	-1,000	-1,000	-1,200	-1,000
GA	Glynn	29	7,300	-100	-500	-500	ñ	ñ	-100	ñ
GA	Hart	98	34,400	-300	ñ	-200	-200	-200	ñ	-100
GA	Heard	3,545	15,936,700	2,500	700	100	2,100	2,100	500	-200
GA	Houston	217	219,200	200	ñ	ñ	100	100	ñ	ñ
GA	Jackson	635	347,100	-1,400	-100	-500	100	100	ñ	200
GA	Mitchell	112	96,400	200	ñ	200	100	100	ñ	200
GA	Monroe	3,520	20,717,900	1,000	100	1,100	1,200	1,200	-700	600
GA	Murray	1,094	2,012,900	1,500	ñ	100	700	700	ñ	100
GA	Polk	212	156,300	600	ñ	300	400	400	ñ	200
GA	Putnam	1,113	2,758,500	-2,200	-66,800	-10,700	-2,200	-2,200	-55,000	-7,900
GA	Talbot	295	233,700	300	ñ	100	200	200	ñ	100
GA	Upson	431	532,600	800	ñ	300	700	700	ñ	300
GA	Walton	441	253,800	-1,100	ñ	-600	-200	-200	ñ	-300
GA	Washington	161	74,900	-200	ñ	-100	-100	-100	ñ	-100
KY	Carroll	2,066	13,858,700	-200	ñ	-400	-100	-100	-200	-400
KY	Clark	686	517,600	-2,300	ñ	-300	-400	-400	ñ	ñ
KY	Daviess	413	2,644,400	100	900	ñ	100	100	900	100
KY	Hancock	260	1,178,300	-700	-1,100	-2,600	-800	-800	-800	-1,900
KY	Henderson	316	2,544,500	-100	-100	ñ	-100	-100	-100	ñ
KY	Jefferson	2,181	12,656,100	-400	-2,000	-1,700	-400	-400	-1,500	-1,400
KY	Marshall	257	166,800	-800	ñ	ñ	-200	-200	ñ	ñ
KY	Mason	1,442	9,519,800	-500	-300	-200	-400	-400	-200	-200
KY	McCracken	1,151	7,677,700	-300	3,500	500	500	500	4,200	1,500
KY	Mercer	1,199	3,521,800	-1,900	-1,700	-2,500	-1,400	-1,400	-1,900	-1,700
KY	Muhlenberg	2,221	15,769,700	2,000	-1,000	3,500	2,000	2,000	-400	3,000
KY	Ohio	409	3,204,900	-300	-1,200	-200	-300	-300	-900	-100
KY	Pulaski	320	1,119,50	-700	-5,600	-1,200	-600	-600	-4,500	-900

			0							
KY	Trimble	1,879	8,910,000	-2,000	-500	-800	-1,400	-1,400	-300	-600
KY	Webster	520	4,029,500	-100	-3,800	-400	-100	-100	-3,000	-300
VA	Buckingham	565	3,238,200	900	ñ	ñ	400	400	ñ	ñ
VA	Caroline	800	773,100	-600	-100	-400	500	500	ñ	400
VA	Chesapeake (City)	745	1,555,900	-1,700	-13,000	-2,700	-1,100	-1,100	-9,100	-1,600
VA	Chesterfield	1,709	9,673,700	100	100	-400	300	300	100	-400
VA	Fauquier	949	866,400	-700	-100	100	800	800	ñ	500
VA	Fluvanna	636	2,920,400	100	ñ	700	100	100	ñ	400
VA	Halifax	917	6,081,000	-100	-100	-400	-100	-100	-100	-300
VA	Hanover	715	3,634,600	-1,200	ñ	100	ñ	ñ	ñ	200
VA	Henrico	237	50,600	-900	-500	-2,100	-700	-700	ñ	-1,100
VA	Hopewell (City)	228	812,400	100	-100	1,000	300	300	ñ	900
VA	King George	253	933,200	-200	-100	-100	ñ	ñ	-100	-100
VA	Louisa	631	848,400	-1,600	-100	-500	-100	-100	ñ	100
VA	Prince William	1,015	3,788,400	-1,500	-11,000	-3,100	-1,300	-1,300	-7,800	-2,200
VA	Richmond (City)	197	255,200	-200	-200	-100	-200	-200	ñ	ñ
VA	Surry	284	54,800	-1,000	-600	-1,700	-500	-500	ñ	-600
VA	Warren	65	209,200	ñ	ñ	ñ	ñ	ñ	ñ	ñ
VA	York	960	1,162,100	-3,300	-34,900	-9,500	-2,700	-2,700	-25,600	-7,000

Exhibit B - Kentucky Email on AVERT Geographic and Temporal Issues in need of consideration. (email forwarded from Aron Patrick – 4-20-15)

AVERT is a great tool for estimating the effectiveness of projects nationally and over the near-term; however, I have two main cautionary reservations, which do not necessarily mean it shouldn't be used, but are just some points to consider when reviewing emissions reductions estimates from AVERT.

The first weakness is in the geographic simplification of the dispatch area into regions, i.e. grouping Kentucky and South Carolina into the South East, or even grouping projects into states, i.e. assuming that a reduction in TVA's nuclear and renewable-powered service territory is comparable to a reduction in Kentucky Power's coal-heavier territory. If we used default dispatching across the Southeast without modification, **emissions reduction from cleaner states would be severely exaggerated**, e.g. South Carolina that emitted only 727 lbs of CO_2 per MWh in 2014, while simultaneously **underestimating the effectiveness of programs in dirtier states like Kentucky**, which emitted over 2053 lbs of CO_2 per MWh in 2014. State-level dispatching is going to produce a much more accurate result, but is still less accurate than a utility-specific dispatch footprint. On our conference calls this past summer with the developers at Synapse, they explained how to edit the plants included in the model's dispatching to handle this problem; however, it require some editing of the programs on board databases and not just simply using the easy default settings. Whoever is using the tool should be versed in editing the database of plants and on the importance of doing so, or else the effectiveness of specific projects will be distorted. On aggregate, these regional distortions will wash out in the averaging, and assuming comparable deployment of RE and DSM between states, make the aggregate forecasts fairly accurate.

The second problem is in temporal simplification of dispatching. While AVERT has done much better than our Kentucky Electricity Portfolio Model for near-term (2015-2018) RE or DSM emissions reductions because it has a very realistic time of day dispatching based on historical load duration curves, for long-term forecasting (2020-2040), AVERT is not capable of taking into account the impending changes to the electricity portfolio as a result of MATS, CSAPR, or later even the CPP—should that affect a state's portfolio. For example, while RE or DSM implemented in Kentucky in 2014 would reduce 2053 lbs of CO_2 , all of our long-term projects put CO_2 emissions near 1760 before 2020, such that a DSM project implemented in the 2020's would only be offsetting 1760 lbs. The static emissions multipliers in AVERT could be problematic. The further out the DSM project is going to be implemented, the AVERT forecast will become increasingly inaccurate because it doesn't take into account the rapidly changing nature of our electricity generating portfolio. **For projects conducted 2020 and beyond, AVERT is going to severely over-estimate emissions reductions.** However, this could be to the clear advantage of the state implementing the programs, they will get credited for more emissions than they will actually offset, particularly as the attached write up notes, AVERT is "readily accepted by the EPA".